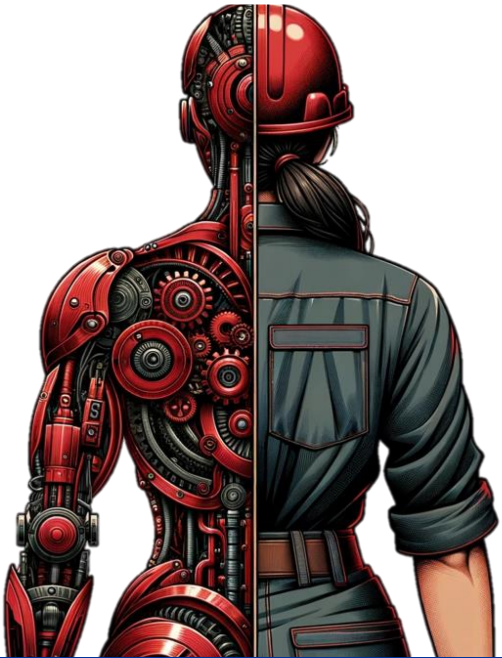
PUBLIC PHD DEFENCE FOR THE DEGREE OF
DOCTOR IN REHABILITATION SCIENCES AND PHYSIOTHERAPY

THE IRON MAN PARADOX: BALANCING INNOVATION AND LIMITATIONS IN OCCUPATIONAL BACK EXOSKELETONS



RENEE GOVAERTS

MONDAY, NOVEMBER 13TH 2022 AT 17:00
PROMOTIEZAAL D2.01, CAMPUS ETTERBEEK

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ABSTRACT OF THE RESEARCH

Work-related musculoskeletal disorders (WMSDs) are still highly prevalent in the industrial work context despite ongoing efforts. A comprehensive review and meta-analysis in Chapter 2 as part of this PhD dissertation revealed noteworthy 1-year prevalence rates for various WMSDs. Back WMSDs were most prevalent in Europe with rates of ~60 % (range: 38–72%). Findings underscore the importance of implementing effective prevention strategies, with a particular emphasis on addressing back-related concerns.

One of such emerging prevention strategies are occupational back-support exoskeletons, which are wearable structures designed to physically support users and mitigate risk factors associated with back WMSDs. Two main categories of back exoskeletons exist: (i) active back exoskeletons that are usually electrically or pneumatically powered, and (ii) passive back exoskeletons, which solely use deformation of springs or other elastic materials to store and return kinetic energy. Chapter 3 delves into the disparities between active and passive back-support exoskeletons in terms of work performance. The active device often obstructed work performance during various simulated tasks, likely due to its rigid and bulky design, limiting user mobility. In contrast, the passive device is designed more flexible and lightweighted, generally hindering work performance less. Despite differences in design, both devices provided similar levels of user comfort.

While Chapter 3 predominantly centered around the physical aspects of exoskeleton performance, it is important to note that industrial tasks typically encompass both physical and cognitive components. Industrial workers, therefore, are faced by a combined set of physical and cognitive workloads. In Chapter 4, an examination of work performance disparities considered both dimensions. The analysis revealed that active and passive exoskeletons led to an overall increase in workload without significantly differing from each other. Taking the results of Chapter 3 into account, it was hypothesized that this observed increase was mainly attributed to the fitting challenges (cognitive component) in the passive exoskeleton condition, while pinpointing the restricting design (physical component) to the active exoskeleton condition.

Recognizing the humans-exoskeletons interaction beyond the pure physical aspects, Chapter 5 delved deeper into the cognitive aspects. Specifically, it investigated an artificially induced cognitive overload scenario for users working with a passive exoskeleton. The key finding was that the combined effect(s) of mental fatigue and exoskeleton usage significantly hindered physical work performance, exemplified by an increased movement duration.

As it becomes evident that exoskeleton usage could initially increase workload, it is crucial to recognize that the impact on work performance hinges on the intricate interplay between the individual, exoskeleton type, and the task specifics. Moreover, the challenge of developing effective occupational back exoskeletons revolves around striking the balance between providing adequate support and minimizing additional workloads. This fundamental predicament has been termed the "Iron Man paradox" in this dissertation, drawing a parallel to the iconic Iron Man suit from Marvel. Pursuing maximal support, like a fictional Iron Man's suit, could counterintuitively lead to issues like increased weight, heat, bulkiness, and limited range of motion which could hamper work performance. Conversely, when prioritizing seamless user integration such as lighter, unrestricted designs, as shown in the Iron Man movies, essential back support could be compromised, and preventive benefits reduced.

CURRICULUM VITAE

Renée Govaerts is a doctoral student within the Human Physiology and Sports Physiotherapy Research Group (MFYS). She obtained her Master's degree in Rehabilitation Sciences and Physiotherapy with a specialization in Musculoskeletal Disorders from the University of Antwerp in 2019. In the same year, she also completed her degree in Healthcare Management at Erasmushogeschool Brussels. Subsequently, she initiated her PhD as a researcher in the European Horizon 2020 SOPHIA project, where she focused on the holistic evaluation of occupational back-support exoskeletons in the industry.